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(54) **ROTARY CLAMP HAVING AN ADJUSTABLE PRE-STOP**

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(52) **U.S. Cl.** **269/32**; 269/228; 269/27; 269/91
(58) **Field of Search** 269/32, 228, 27, 269/24, 201, 233, 91, 93, 238

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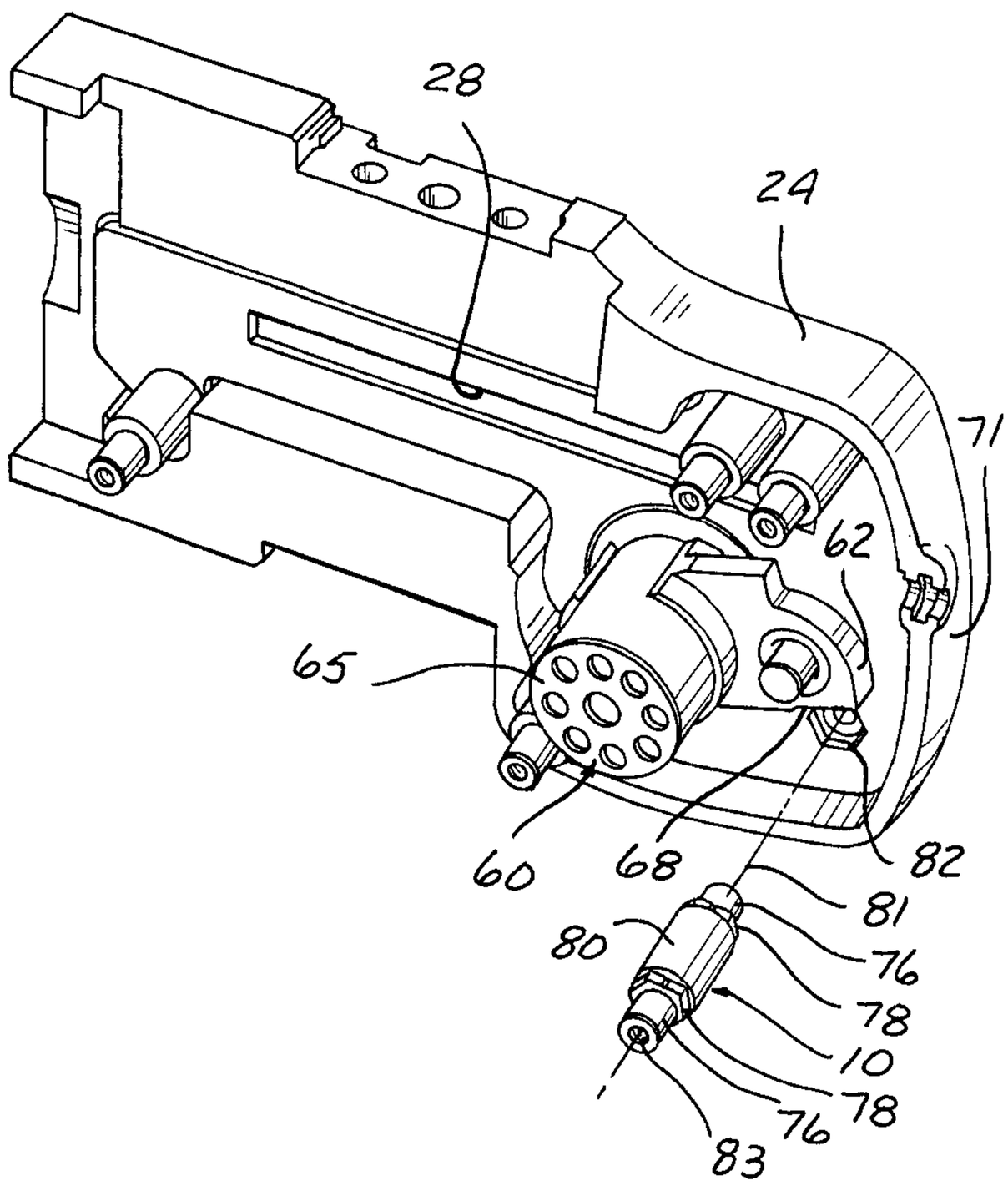
(57) **ABSTRACT**

A rotary clamp having an adjustable pre-stop wherein the rotary clamp includes a linear actuator for transmitting linear motion to a linkage assembly. The linkage assembly converts the linear motion into rotary motion of a clamp arm, wherein the clamp arm moves between a clamped position and an unclamped position. The adjustable pre-stop provides a substantially cylindrical member having a substantially polygonal shaped surface formed on the cylindrical member. The polygonal surface matingly engages a substantially polygonal shaped aperture formed in the housing of the rotary clamp. An eccentric mid-portion of the cylindrical member engages the linkage assembly in the clamped position to prohibit the clamp arm from rotating beyond the clamped position. The eccentric mid-portion provides a plurality of predetermined radial distances extending from the longitudinal axis corresponding to predetermined rotational positions of the hexagonal surface relative to the hexagonal aperture, wherein the predetermined radial distances correspond to predetermined incremental angular adjustments of the clamp arm in the clamped position.

18 Claims, 3 Drawing Sheets



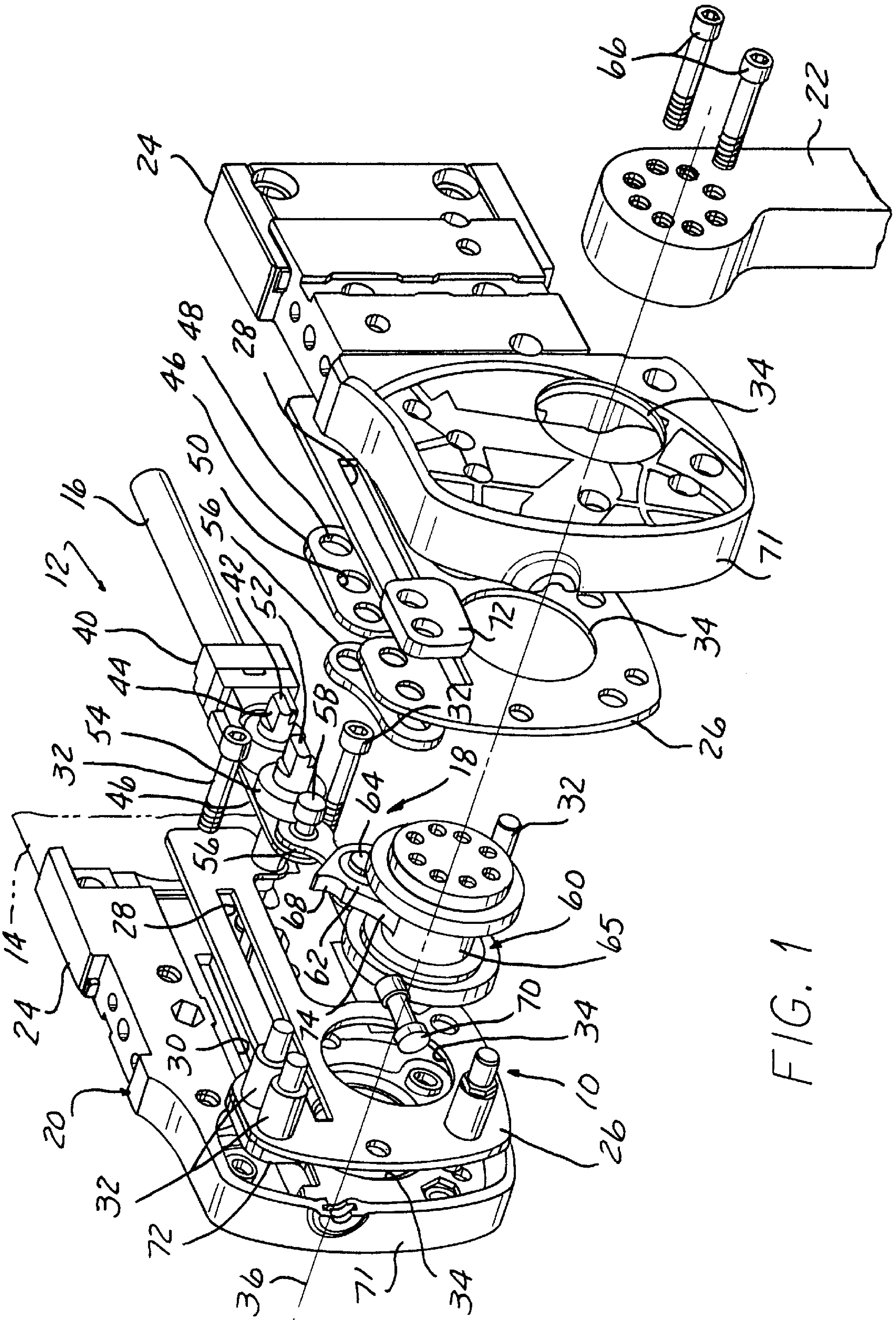

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FIG. 1

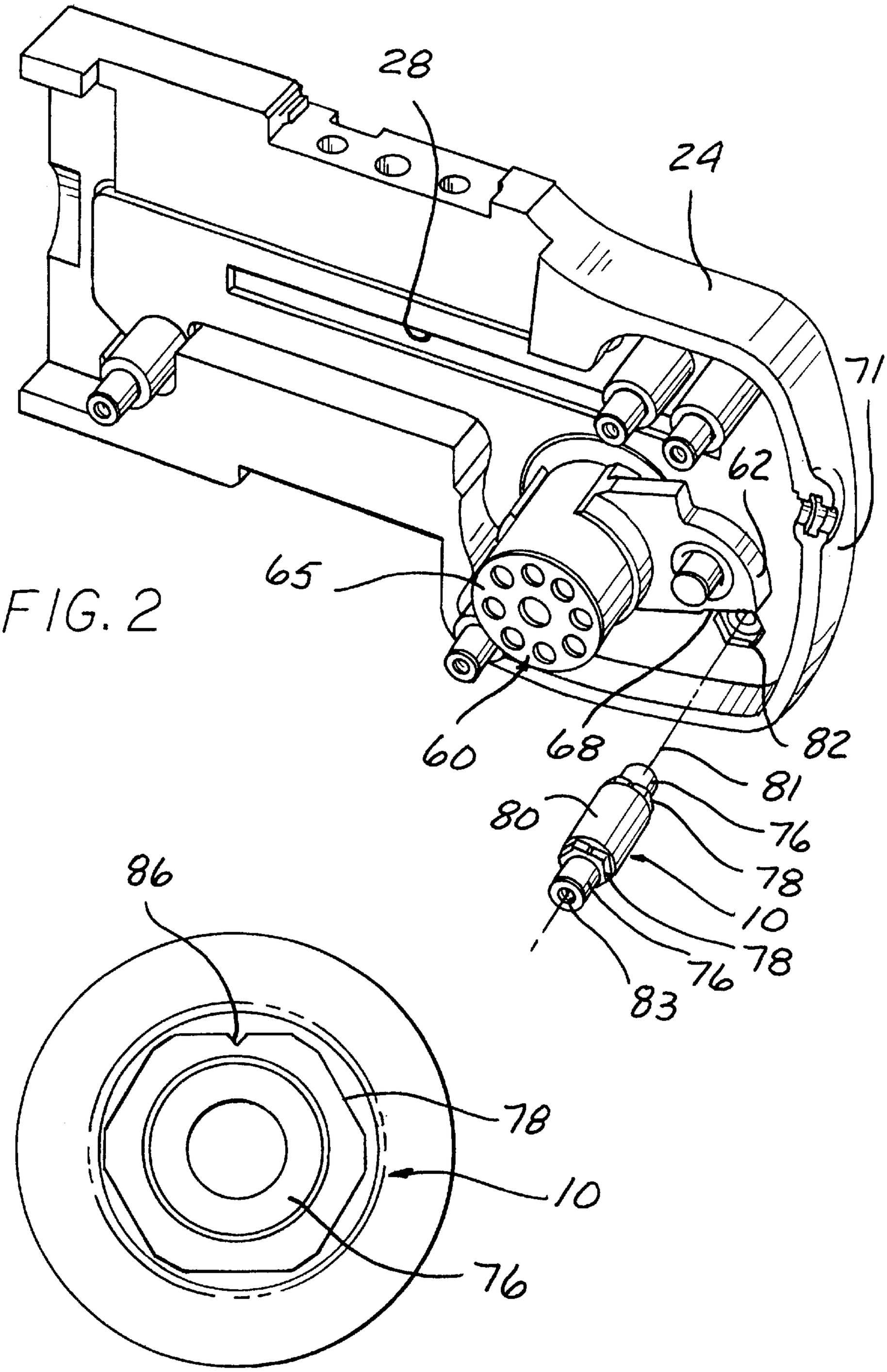

FIG. 2

FIG. 5

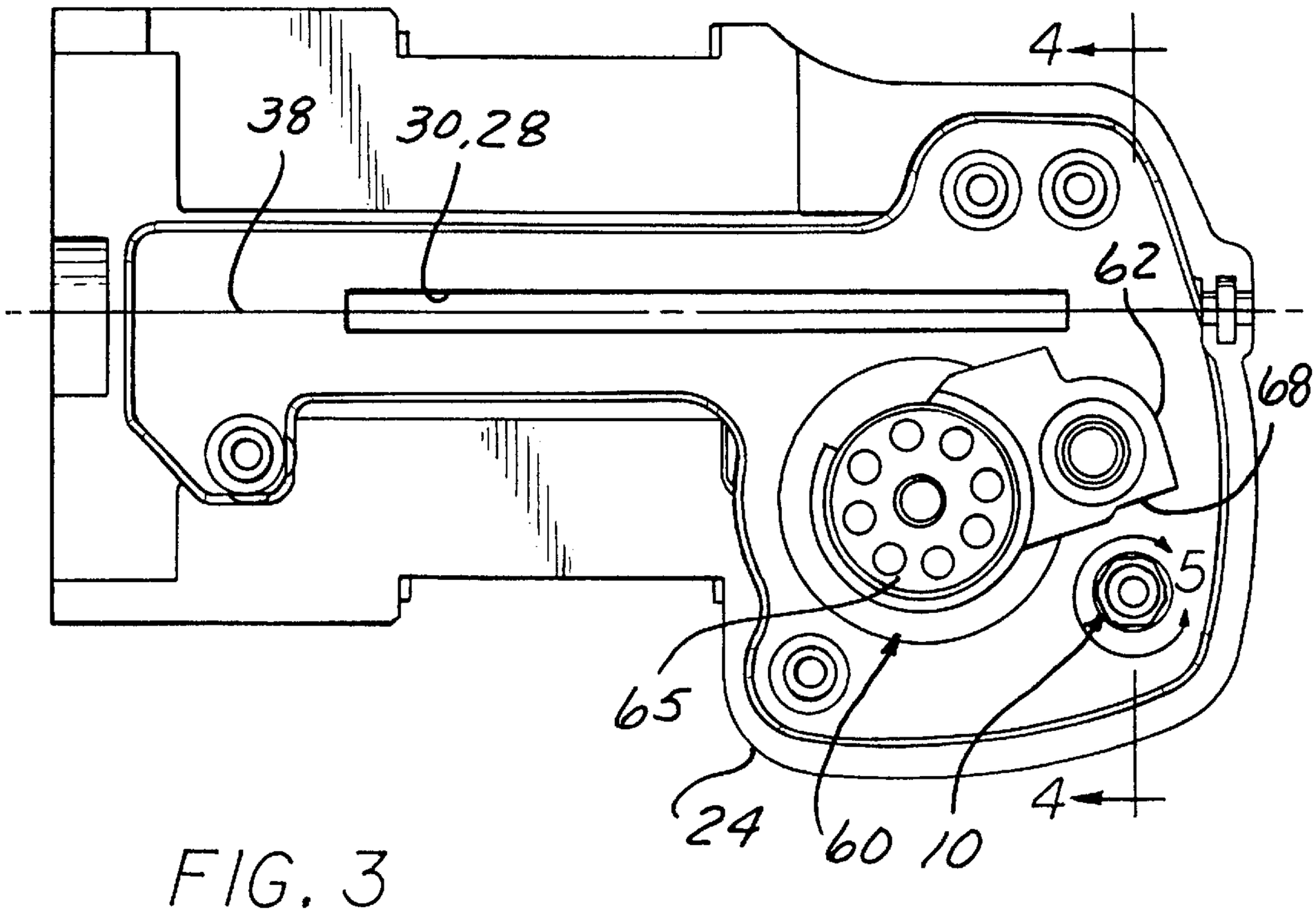

FIG. 3

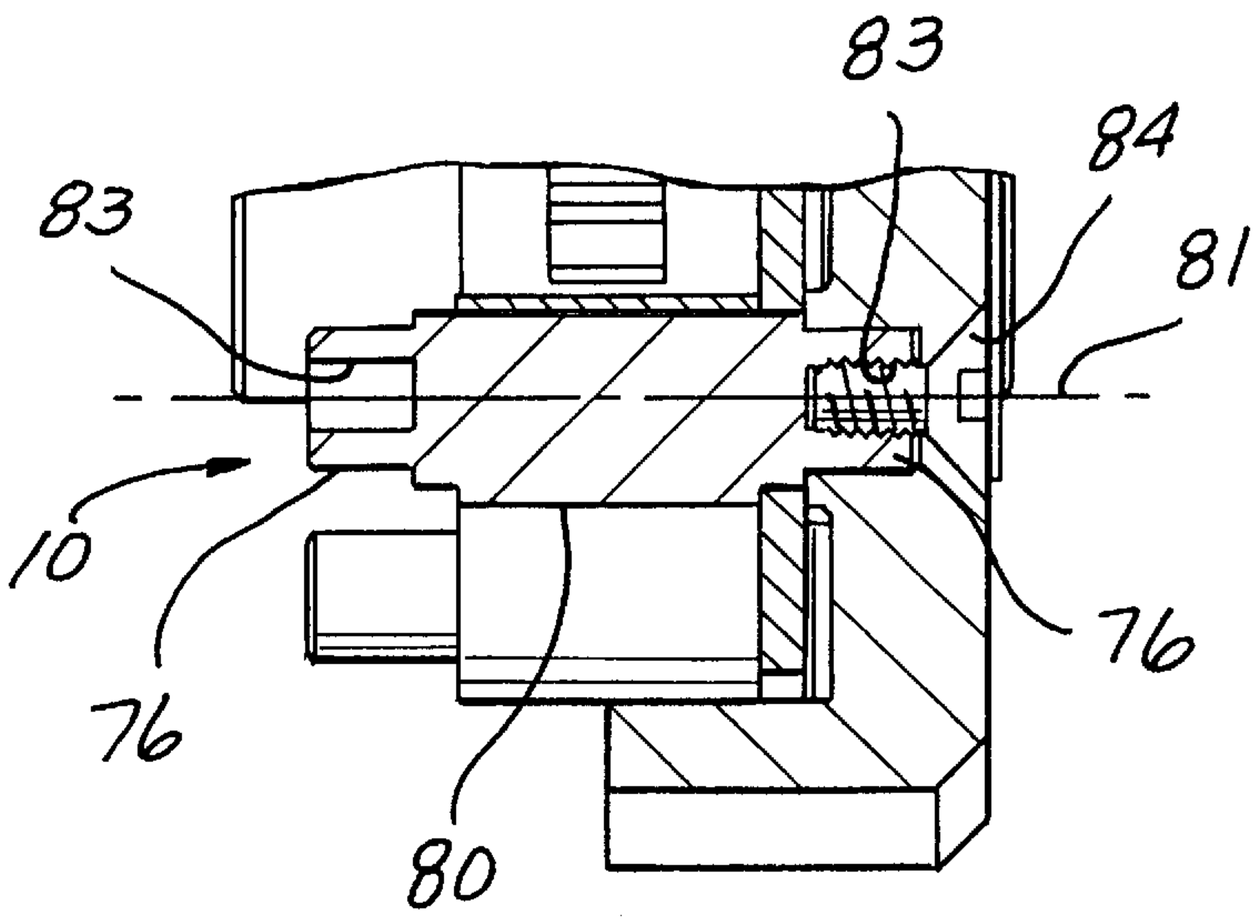

FIG. 4

ROTARY CLAMP HAVING AN ADJUSTABLE PRE-STOP

FIELD OF THE INVENTION

The present invention relates, in general, to rotary clamps, and more particularly, to a rotary clamp having an adjustable pre-stop that allows for incremental adjustments of a clamp arm in a clamped position.

BACKGROUND OF THE INVENTION

Rotary clamps are known of the type in which linear actuator reciprocating movement is adapted to be translated into rotary movement of a clamp arm. The linear actuator is powered by a fluid motor, and a linkage assembly converts the linear actuator movement into rotary motion of the clamp arm. The clamp arm typically clamps a workpiece against a workpiece engaging surface. Thus, it is critical that the clamp arm repeatedly and accurately position itself in a clamped position.

It is known to utilize positive stops or pre-stops to prevent the clamp arm from exceeding a predetermined position. It is also known to utilize an eccentric pre-stop that may be rotatably adjusted to cooperatively engage the clamp arm in the clamping position. The eccentric pre-stop may be rotatably adjusted to eliminate any variation in the arm position due to a loose linkage mechanism. However, the eccentric pre-stops of past designs provide an infinite number of clamping positions for the clamp arm thereby making it difficult to utilize repeatable settings on the pre-stop. In addition, the eccentric pre-stop may be susceptible to rotational movement should the fastener that holds the eccentric pre-stop become slightly loose.

It would be desirable to provide an adjustable pre-stop that provided predetermined positions corresponding to various rotary positions of the clamp arm in the clamped position. In addition, it would also be desirable to provide an adjustable pre-stop that was not susceptible to rotational movement upon the loosening of its fastener.

SUMMARY OF THE INVENTION

The present invention overcomes the above-noted shortcomings by providing a rotary clamp having an adjustable pre-stop. The rotary clamp includes means for converting linear actuator motion between a first position and a second position into rotary clamp motion between an unclamped position and a clamped position, respectively. The converting means is disposed within a housing of the rotary clamp wherein the housing provides at least one shaped aperture formed therein. A substantially cylindrical member having a longitudinal axis has at least one shaped surface for matingly engaging the shaped aperture in the housing. The cylindrical member also provides an eccentric outer portion relative to the longitudinal axis for engaging the converting means to prohibit said converting means from moving beyond the clamped position. The eccentric outer portion creates a plurality of predetermined radial distances extending from the longitudinal axis of the cylindrical member. The radial distances correspond to predetermined rotational positions of said shaped surface within the shaped aperture of the housing wherein said predetermined radial distances correspond to predetermined incremental angular adjustments of said converting means in said clamped position. An indicia may be provided on the shaped surface of the cylindrical member to indicate the position of the cylindrical member relative to the shaped aperture in said housing.

Other options and features of the invention will become apparent by reference to the following specifications and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings, like referenced numerals refer to similar elements, throughout the various views.

FIG. **1** is an exploded view of a rotary clamp utilizing the adjustable pre-stop of the present invention.

FIG. **2** is a partial exploded view of the rotary clamp housing and the adjustable pre-stop of the present invention.

FIG. **3** is a front view of the adjustable pre-stop mounted in the housing of a rotary clamp.

FIG. **4** is a sectional view of the adjustable pre-stop shown in the direction of arrows **4—4** in FIG. **3**.

FIG. **5** is a sectional view of the adjustable pre-stop taken in the direction of arrows **5—5** in FIG. **3**.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, the present invention will now be described in detail with reference to the preferred embodiment.

FIGS. **1–5** illustrate a rotary clamp **12** having an adjustable pre-stop **10** defined by the present invention. The adjustable pre-stop **10** is utilized within the rotary clamp **12** which is actuated by means of a fluid cylinder or linear actuator **14**. The linear actuator **14** provides a piston (not shown) attached to the end of a piston rod **16**. The fluid cylinder or linear actuator **14** is preferably pneumatic, but the fluid cylinder or linear actuator **14** may also be hydraulic. The linear actuator **14** provides linear reciprocating movement to the piston rod **16** which, in turn, is coupled to a linkage assembly **18** of the rotary clamp **12**. The linkage assembly **18** is disposed within a housing **20** of the rotary clamp **12** and converts the linear motion of the piston rod **16** into rotary motion of a clamp arm **22**. The reciprocal linear movement of the linear actuator **14** and piston rod **16** correspond to reciprocal rotary movement of the clamp arm **22** between a clamped position and an unclamped position.

The housing **20** of the rotary clamp **12** is formed by two bilateral halves **24** wherein one end of the housing **20** is attached to the linear actuator **14** and the other end of the housing **20** is closed. The end of the housing **20** connected to the linear actuator **14** is open to receive the free end of the piston rod **16**. The two halves **24** of the housing **20** form a hollow portion having a pair of laminated plates **26** disposed therein. Each of the laminated plates **26** provides an elongated guide slot **28** that is aligned with an elongated guide slot **30** formed in the inner surfaces of the two halves **24** of the housing **20**. The two halves **24** of the housing **20** and the pair of laminated plates **26** are connected together by fasteners **32**. The housing **20** also includes a series of coaxial apertures **34** extending through the two halves **24** and the laminated plates **26** of the housing **20**. The coaxial apertures **34** have a common axis **36** offset from and perpendicular to a longitudinal axis **38** of the guide slots **28, 30**.

To connect the piston rod **16** to the linkage assembly **18,** a rod end **40** having a U-shaped block structure threadingly engages and receives a stem-like portion of the free end of the piston rod **16**. The rod end **40** provides a pin **42** that extends through an aperture provided in the rounded end of the U-shaped portion. Each end of the pin **42** has substantially flat parallel landings **44** that engage the elongated guide slots **28, 30** of the housing **20**. The pin **42** is pivotally

connected to a pair of substantially parallel linkage members **46** wherein each linkage member **46** has apertures **48** extending therethrough for receiving pin **42**. The apertures **48** may also be elongated (shown in hidden lines) to offer movement of the pin **42** within aperture **48** during movement of the rotary clamp **12** between the clamped and unclamped positions. The linkage members **46** also provide a second aperture **50** extending therethrough for receiving a second pin **52** similar to pin **42**. Pin **52** is also received by an aperture extending through a substantially circular rubber roller **54** disposed between the linkage members **46**. The substantially flat landings of the pin **52** similarly engage the elongated slots **28, 30** of the housing **20** as described for pin **42**.

The linkage assembly **18** is further defined by the linkage members **46** being pivotally connected to a pair of substantially parallel links **56**. At one end of links **56**, a pin **58** extends through corresponding apertures provided in the linkage members **46** and the links **56**. At the opposite end of links **56**, the links **56** are pivotally connected to a shaft link **60**. The shaft link **60** includes a lever arm **62** having an aperture extending therethrough. A pin **64** is inserted through aligned apertures provided in links **56** and lever arm **62** of the shaft link **60**. The shaft link **60** also includes a pivot pin **65** integrally connected to the lever arm **62**. The pivot pin **65** is substantially cylindrical and is rotatably disposed within the coaxial apertures **34** provided in the housing **20** so that a portion of the pivot pin **65** extends slightly outward from the housing **20**. The clamp arm **22** is connected to a portion of the pivot pin **65** that extends slightly outward from the housing **20** by fasteners **66**. The shaft link **60** also provides a positive stop **68** integrally formed in the lever arm **62**. The positive stop **68** engages the adjustable pre-stop **10** which extends between the interior walls of the housing **16**. The positive stop **68** may provide either a substantially flat surface, as shown in FIGS. **2** and **3**, or an arcuate surface, as shown in FIG. **1**, for engaging the adjustable pre-stop **10** and limiting the travel of the clamp arm **22** in the clamped position.

Even though the rotary clamp **12** is designed not to open unexpectedly upon the loss of power and/or air pressure to the linear actuator **14**, it may be desirable to move the rotary clamp **12** to the unclamped position in order to release a workpiece (not shown) or reset the linkage assembly **18**. A reciprocal member **70** is slideably disposed within an aperture provided within an end wall **71** of the housing **20**. The reciprocal member **70** has a cylindrical body with a pair of larger cylindrical end portions integral with the body of the reciprocal member **70**. The larger end portions capture the reciprocal member **70** within the end wall **71** of the housing **20**. Reciprocal member **70** is aligned with the longitudinal axis **38** of the elongated slot **28, 30** so that the reciprocal member **70** is displaced by the linkage assembly **18** when the rotary clamp **12** is in the clamped position. If power or air is lost to the rotary clamp **12** when in the clamped position, the reciprocal member **70** may be struck to move the linkage assembly **18** toward the unclamped position.

To allow the linkage assembly **18** to move to an over-center position without risking wear of the internal mechanisms of the rotary clamp **12**, the present invention provides a wedging assembly that effectively wedges the linkage assembly **18** into the clamped position. This is accomplished by mounting two wear blocks **72** on the outside of the laminated plates **26** just above the guide slot **28** provided in the laminated plates **26**. The wear blocks **72** engage the flat landing areas **44** provided on pins **42, 52** when the rotary clamp **12** moves into the clamped position. Further upward pressure is applied to the pins **42, 52** against the wear block **72** by having the roller **54** roll on an inclined surface **74** provided on the lever arm **62** of the shaft link **60**. The inclined surface **74** acts as a ramp by which the roller **54** engages and rolls onto when the rotary clamp **12** is moving into the clamped position. By providing the inclined surface **74** on the lever arm **62**, the roller **54** provides an increasing force on pins **42, 52** against the wear block **72** while little or no force is applied to links **56**. This assures that the clamp **12** is tightly secured when in the clamped position while also ensuring that no excessive wear is occurring to the linkage assembly **18**.

In order to provide incremental angular adjustment of the clamp arm **22** in the clamped position, the adjustable pre-stop **10** provides a plurality of predetermined settings by which the clamp arm **22** may be adjusted in the clamped position. The adjustable pre-stop **10** is substantially cylindrical with a stepped diameter that extends between the inner walls of the two bilateral halves **24** of the housing **20**. The adjustable pre-stop **10** provides substantially cylindrical end portions **76** having a shaped surface **78** formed adjacent each end portion **76**. The shaped surface **78** preferably has a polygonal configuration, such as a hexagon. The middle portion **80** of the adjustable pre-stop **10** comprises an eccentric cylindrical portion which is eccentric relative to a longitudinal axis **81** of the adjustable pre-stop **10**. The end portions **76** are received by apertures in the inside walls of the housing **20**, and the hexagonal shaped surfaces **78** are received by matingly-engaging, hexagonal shaped apertures **82** also formed in the inside walls of the two halves **24** of the housing **20**. The hexagonal shaped apertures **82** are concentric with the apertures in the inside walls of the housing **20**. The adjustable pre-stops **10** are secured by threaded fasteners **84** that extend through the bilateral halves **24** of the housing **20** and are threaded into threaded bores **83** in the ends of the adjustable pre-stop **10**. The mating engagement of the hexagonal shaped surfaces **78** of the pre-stop **10** with the hexagonal shaped apertures **82** in the housing **20** prohibits the pre-stop **10** from rotating about its longitudinal axis **81**.

The eccentricity of the mid-portion **80** of the adjustable pre-stop **10** causes the radius of the mid-portion **80** of the adjustable pre-stop **10** to vary as the adjustable pre-stop **10** rotates. Each time the hexagonal shaped surface **78** of the adjustable pre-stop **10** rotates in a different position with respect to the hexagonal aperture **82** provided in inside walls **24** of the housing **20**, the lever arm **62** of the shaft link **60** engages the pre-stop **10** in a slightly different position, thereby causing the angular position of the clamp arm **22** to vary in the clamped position. The six sides of the hexagonal portion **78** allow for six predetermined positions of the adjustable pre-stop **10**. A mark, indentation or indicia **86** is provided on the hexagonal shaped surface **78** of the adjustable pre-stop **10** to provide an orientation or reference as to the location of the adjustable pre-stop **10**. The indicia **86** ensures the repeatability of the rotary clamp **12** settings once the position of the adjustable pre-stop **10** has been moved or changed.

In operation, a user (not shown) first determines that an adjustment must be made to the position of the clam arm **22** in the clamped position. To adjust the clamp arm **22**, the fasteners **84** securing the pre-stop **10** to the housing **20** are removed, and the housing **20** is separated into its bilateral halves **24**. The pre-stop **10** is removed from the hexagonal aperture **82** provided in the inner walls of the housing **20** rotated to the desired position. The indicia **86** indicates the position of the pre-stop **10** and the adjustment of the clamp

arm **22**. The hexagonal shaped surfaces **78** are then seated in the hexagonal shaped apertures **82**, and the housing **20** is closed. The fasteners **84** are threaded to secure the pre-stop **10** to the housing **20**, and the rotary clamp **12** is ready for use.

While the invention has been described in what is presently considered to be the most practical and preferred embodiment, it is to be understood that the invention is not to be limited to the disclosed embodiments, but to the contrary, it is intended to cover various modifications and equivalent arrangements, included within the spirit and scope of the appended claims. The scope is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures as is permitted under the law.

What is claimed is:

1. A rotary clamp comprising:

means for converting linear actuator motion between a first position and a second position into rotary motion of a clamp arm between an unclamped position and a clamped position, respectively;

a housing having said converting means disposed therein and a shaped aperture formed therein;

a substantially cylindrical member having a longitudinal axis and a shaped surface for matingly engaging said shaped aperture in said housing or in a portion of said housing defining said shaped aperture engages said shaped surface to prohibit rotational movement of said cylindrical member about said longitudinal axis; and

said cylindrical member having an eccentric outer portion relative to said longitudinal axis for engaging said converting means in said clamped position to prohibit said converting means from moving beyond said clamped position, and said eccentric outer portion creating a plurality of predetermined radial distances from said longitudinal axis to said outer portion corresponding to predetermined rotational positions of said shaped mating surface within said shaped mating aperture, wherein said predetermined radial distances correspond to predetermined incremental angular adjustments of said converting means in said clamped position.

2. The rotary clamp stated in claim **1**, wherein each of said shaped surfaces and apertures further comprise:

a substantially polygonal-shaped surface and aperture, respectively.

3. The rotary clamp stated in claim **1**, further comprising:

said cylindrical member having a threaded bore in at least one of said ends of said cylindrical member; and

at least one fastener extending through a corresponding aperture provided in said housing for threadingly engaging said threaded bore in said cylindrical member and prohibiting movement of said cylindrical member along said longitudinal axis.

4. The rotary clamp stated in claim **1**, further comprising:

an indicia formed on said shaped surface of said cylindrical member to indicate the position of said cylindrical member relative to said shaped mating aperture in said housing.

5. The rotary clamp stated in claim **1**, wherein said converting means comprises:

a linkage assembly having one end engageable with a linear actuator and another end engageable with a clamp arm.

6. The rotary clamp stated in claim **5**, wherein said linkage assembly further comprises:

a shaft link engaging said eccentric outer portion of said cylindrical member in said clamped position.

7. The rotary clamp stated in claim **1**, further comprising:

said shaped surface of said cylindrical member being coaxial with said longitudinal axis.

8. A rotary clamp comprising:

a linkage assembly for converting linear actuator motion between the first position and a second position into rotary motion of a clamp arm between an unclamped position and a clamped position, respectively;

a housing having said linkage assembly disposed therein and a pair of polygonal apertures formed therein;

a substantially cylindrical member having a longitudinal axis and a polygonal surface formed at each end of said cylindrical member, wherein said polygonal surfaces matingly engage said polygonal apertures formed in said housing wherein a portion of said housing defining said polygonal apertures engages said polygonal surfaces to prohibit rotational movement of said cylindrical member about said longitudinal axis; and

said cylindrical member having an eccentric outer portion formed thereon relative to said longitudinal axis for engaging said linkage assembly in said clamped position and prohibiting said linkage assembly from moving beyond said clamped position, and said eccentric outer portion creating a plurality of predetermined radial distances extending from said longitudinal axis to said outer portion corresponding to predetermined rotational positions of said polygonal surfaces within said polygonal apertures in said housing, or in said predetermined radial distances correspond to predetermined incremental angular adjustments of said linkage assembly in said clamped position.

9. The rotary clamp stated in claim **8**, wherein said polygonal shape surfaces and apertures comprise:

substantially hexagonal shaped surfaces and apertures, respectively.

10. The rotary clamp stated in claim **8**, further comprising:

said cylindrical member having a threaded bore in each of its ends; and

a fastener extending through an aperture provided in opposing interior walls of said housing for threadingly engaging said threaded bores in said cylindrical member and prohibiting movement of said cylindrical member along said longitudinal axis.

11. The rotary clamp stated in claim **8**, further comprising:

an indicia formed on said polygonal surface of said cylindrical member to indicate the position of said cylindrical member relative to said polygonal apertures in said housing.

12. The rotary clamp stated in claim **8**, further comprising:

said linkage assembly having one of its ends connectable with a linear actuator and another of its ends connectable with a clamp arm.

13. The rotary clamp stated in claim **12**, wherein said linkage assembly further comprises:

a shaft link including a lever arm for engaging said eccentric outer portion of said cylindrical member.

14. The rotary clamp stated in claim **8**, further comprising:

said polygonal surface of said cylindrical member being coaxial with said longitudinal axis.

15. An improved rotary clamp for securing a workpiece relative to a workpiece support, including a linear actuator having a piston and a piston rod connected thereto for transmitting linear motion; an enclosed housing axially

aligned with said linear actuator for receiving said piston rod; a linkage assembly having one of its ends connected to said piston rod and another of its ends connected to a clamp arm, wherein said linkage assembly converts said linear actuator motion between a first position and a second position into rotary clamp motion of said clamp arm between an unclamped position and a clamped position, respectively; the improvement comprising:

a substantially cylindrical member having a longitudinal axis and a shaped surface formed on at least one end of said cylindrical member wherein said shaped surface is coaxial with said longitudinal axis for matingly engaging at least one corresponding shaped aperture formed in at least one inner wall of said housing; and

said cylindrical member having an eccentric outer portion relative to said longitudinal axis for engaging said linkage assembly in said clamped position, and said eccentric portion creating a plurality of predetermined radial distances extending from said longitudinal axis to said outer portion corresponding to predetermined rotational positions of said shaped surface within said shaped aperture of said housing, wherein said predetermined radial distances correspond to predetermined incremental angular adjustments of said clamp arm when said linkage assembly engages said cylindrical member in said clamped position.

16. The rotary clamp stated in claim **15**, wherein said shaped surfaces and apertures further comprise:

substantially polygonal shaped surfaces and apertures, respectively.

17. The improved rotary clamp stated in claim **15**, further comprising:

said cylindrical member having at least one threaded bore in each of said ends of said cylindrical member; and

a fastener extending through an aperture provided in at least one interior wall of said housing for threadingly engaging said threaded bore in said cylindrical member and prohibiting movement of said cylindrical member along said longitudinal axis.

18. The rotary clamp stated in claim **15**, further comprising:

an indicia formed on said shaped surface of said cylindrical member to indicate the position of said cylindrical member relative to said shaped aperture in said housing.

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